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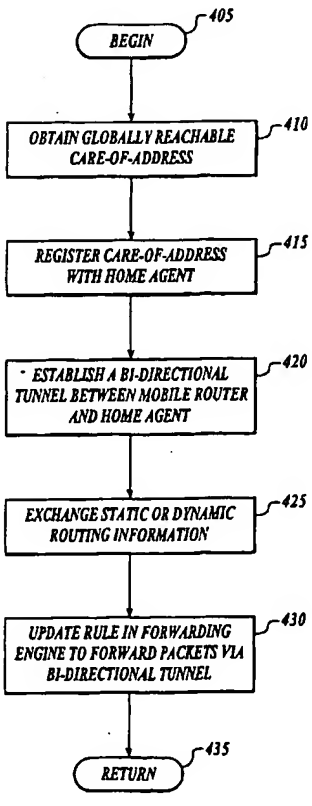
(54) Title: MOBILE ROUTER SUPPORT FOR IPv6



(57) Abstract: A method and system for supporting mobile routers in Internet Protocol version 6 (IPv6) is provided. A mobile router obtains a care-of-address associated with an address configuration (410). The mobile router registers the care-of-address with a home agent (415). A bi-directional tunnel is established between the mobile router and the home agent (420). Packets are then forwarded via the bi-directional tunnel.

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MOBILE ROUTER SUPPORT FOR IPv6

This application is being filed as a PCT International Patent Application in the name of Nokia Corporation, a Finland national corporation and resident, Applicant for all designated countries; and Nokia Inc., a U.S. national corporation and resident, Applicant for St. Lucia only; on 14 November 2002; designating all countries except the US, and claiming priority to U.S. Serial No. 60/336,221 filed 14 November 2001.

Field of the Invention

This invention relates generally to networking and more specifically, to a system and method for supporting mobile routers in IPv6.

Background

Whether walking, flying, or riding, people are frequently traveling. While traveling, they often carry or go with one or more electronic devices. For example, many people carry a cellular phone with them. In addition, while traveling in a car, a person might be traveling with a laptop, car electronics, and other electronic devices.

Maintaining connectivity with the Internet is increasingly becoming more important. People like to check stocks, weather, and correspond via email. They like to have their electronic calendars available at all times and have access to files and Internet content. Gamers like to play other gamers online.

With this need to maintain connectivity comes challenges. Building each device with cellular or satellite communication capabilities might obtain an "always-on" experience but at an economic cost both to producers and consumers. For example, a user may not wish to pay a monthly connection charge for each device the user has. Nor may the user wish to pay more for the capability of each device to connect through a cellular or satellite channel. Thus, there is a need for a means for leveraging existing infrastructure to provide Internet connectivity to a group of devices traveling in a mobile environment.

Summary

A method and system for supporting mobile routers in Internet Protocol version 6 (IPv6) is provided. A mobile router obtains a care-of-address associated with an address configuration. The mobile router registers the care-of-address with a home agent. A bi-directional tunnel is established between the mobile router and the home agent. Packets are then forwarded via the bi-directional tunnel.

In one aspect of the invention, a request is made that packets that include an address prefix within a set of prefixes be forwarded to the mobile router.

In another aspect of the invention, configuration information is forwarded via the bi-directional tunnel. The configuration information may be routing information. The configuration information may be static or dynamic. The configuration information may be encapsulated.

In another aspect of the invention, the mobile router obtains the care-of-address while attaching to a network. The network is associated with a network address. The network address includes a prefix. The care-of-address is generated by combining the prefix with an identifier that identifies the mobile router.

In another aspect of the invention, the home agent receives a packet that includes a home address of the mobile router. The packet is then forwarded via the bi-directional tunnel to the mobile router. The home address of the mobile router may be employed to retrieve the care-of-address from a table included on the home agent.

In another aspect of the invention, a home agent updates a routing table. The routing table includes a routing entry associated with a mobile router that is reachable from the home agent. The home agent receives a packet. The home agent selects a bi-directional tunnel associated with the mobile router. The home agent then tunnels the packet to the mobile router. The packet may be destined to the mobile router or to a node on a mobile network reachable through the mobile router.

According to another aspect of the invention, a system is disclosed that operates substantially according to the aspects described above.

These and various other features as well as advantages, which characterize the present invention, will be apparent from a reading of the following detailed description and a review of the associated drawings.

Brief Description of the Drawings

FIGURE 1 shows a block diagram of a mobile router and a mobile node both at home;

FIGURE 2 shows a block diagram of a mobile node docked in a mobile network;

FIGURE 3 shows a block diagram of a mobile node docked in a mobile network accessed through a mobile router, where the mobile router is attached to a foreign network;

FIGURE 4 shows a flowchart illustrating an exemplary method in which a mobile router operates; and

FIGURE 5 shows a flowchart illustrating an exemplary method in which a home agent operates.

Detailed Description

In the following detailed description of exemplary embodiments of the invention, reference is made to the accompanied drawings, which form a part hereof, and which are shown by way of illustration, specific exemplary embodiments of which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

In embodiments of the invention, a mobile node acting as a mobile router may automatically register with its home domain and preserve sessions to multiple devices moving along with the mobile node. There can be multiple devices, fixed or mobile, behind the mobile router. It is also possible to apply this access method recursively, creating nested mobile networks, which operate within other mobile networks.

On current mobile IPv6-based data communication networks, the mode of operation for mobile networks supports host mobility. Router mobility is assumed as an extension to host mobility such that a subnet can connect to a mobile node and move with it.

Embodiments of the invention described below provide a method by which a mobile router and its home agent can support insertion of forwarding table entries for hosts and networks directly accessible to the mobile router, and moving along with it, whose packets are forwarded by the mobile router to the rest of the Internet. The method considers two cases. The first case is a consumer device which gets a pre-configured static network route from the home agent. The home agent inserts and removes this route as a function of whether the mobile router is registered with its home agent or not. The second case considers a full-featured mobile router which runs a routing protocol as if it were in its home domain. This dynamic routing protocol signaling is extended over bi-directional tunneling between the mobile router and its home agent so that this tunnel seems like a virtual point-to-point link. The link is used to forward packets between the mobile router (and its attached mobile network) and the home network, so that packets to and from the mobile network appear to be processed and returned from the home domain. Thus, mobility is invisible to hosts on the mobile network, and to nodes corresponding to those hosts.

One case when this method is useful is when users with multiple personal devices move and attach to different points of access to the global Internet. The personal devices are assumed to be IPv6 capable and can also connect to the global Internet via a primary device, such as a mobile router. Also, the method enables a distributed organization where a cloud of nodes can connect to a corporate network over the public Internet, e.g., by a secure bi-directional tunnel, and extend the corporate network to a moving set of nodes connected through a mobile router running a dynamic routing protocol.

This method can perform routing in accordance with existing routing protocols. Routing is facilitated by the tunnel between the mobile router and the home agent. Authorization to change the forwarding state stems from the existing agreements implemented by aggregation routers along the path to the home network. The method can be performed without modifying existing protocols. Instead, implementation changes are made in the home agent and mobile router. Furthermore, nodes on the mobile network need not be aware of the mobility of the network.

Embodiments of the invention provide a method whereby a host connected through dynamic and mobile connections to the Internet can act as a router for other hosts traveling with it, with little or no manual configuration.

Embodiments of the invention reuse Mobile IPv6 to allow a mobile router to access the Internet through various care-of-addresses, while maintaining the mobile router's permanent, globally-reachable home address. This is accomplished through the methods described below that improve a Mobile IPv6 implementation to allow router mobility without changing the underlying message formats or adding protocol extensions.

A care-of-address is used when a mobile router is away from its home network. A care-of-address is an address at which the mobile router may be reached while the mobile router is away from its home network. First, the mobile node obtains an address (a care-of-address) on the network to which it attaches. An address (care-of address) may be obtained by a stateless address autoconfiguration, a stateful address configuration, and the like. The stateful address configuration includes those actions where the mobile router may employ Dynamic Host Configuration Protocol (DHCP), a server, or some other mechanism to obtain this address. The stateless address autoconfiguration includes those actions where the mobile router may generate this address by combining a network prefix advertised of the network and an identifier unique to the mobile router. However, the invention is not limited to these approaches, and virtually any mechanism may be employed that enables the mobile router to obtain a care-of-address on the network to which it attaches. In any event, the mobile router then sends a binding update including the care-of-address to the mobile router's home agent. When the home agent receives traffic that is directed to the mobile router's home address, the home agent can then forward the traffic to the mobile router using the care-of-address included in the binding update.

Embodiments of the invention involve using various existing protocols and protocol message exchanges to establish state on both the mobile router and its Mobile IPv6 home agent. This state allows packets destined for the mobile router or any of the hosts connected to a mobile network utilizing the mobile router to be tunneled by the home agent from their usual arrival point at the home network (where the home agent resides) to the mobile router at its current attachment point. Additionally, packets from nodes on the home network are sent

back through the tunnel to the home network and then forwarded as usual from there to their intended destinations. This avoids the packets being ignored by routers at the current attachment point due to incorrect topology. The method may be implemented by adding functionality and packet forwarding rules to the network code in both the mobile router and home agent implementation.

Mobile Router Implementation Changes

FIGURE 4 shows a flowchart illustrating an exemplary method in which a mobile router operates. The mobile router's implementation changes as follows:

(1) When the mobile router is traveling away from its home network and has reached a new attachment point, it obtains a globally reachable care-of-address as specified by an Address configuration (block 410). Address configuration may include stateless address autoconfiguration, stateful address configuration, and the like. In any event, after an address is generated, a check is typically performed to determine whether any other node in the network is using the address. If no other node is using the address (which is typical), the attached node may then use the address.

(2) The mobile router registers its care-of-address with its home agent by sending a Mobile IPv6 Binding Update message, allowing packets arriving at its home network to be tunneled to it at its current attachment point (block 415).

(3) The mobile router establishes a bi-directional tunnel between itself and its home agent (block 420).

(4) The mobile router either uses static configuration information (consumer case) or runs a dynamic routing protocol with its home agent (fully enabled case) to exchange routing information about its mobile network with the home agent (block 425). For example, a cellular phone used as a mobile router would not typically be allowed to update the routing table of a cellular provider's router acting as the cellular phone's home agent. Nor would the cellular phone used as a mobile router wish to obtain all of the routing information available on the cellular provider's router. Rather, the cellular phone may be configured statically to send all outgoing traffic not destined to the mobile network to the cellular provider's router.

On the other hand, a mobile router contained on, for example, a cruise ship with hundreds of computers may be allowed to engage in a dynamic routing protocol and to exchange routing information with the mobile router's home network router and other routers.

(5) In the fully enabled mode, the mobile router runs a dynamic routing protocol with its home agent to exchange up-to-date routing information. The mobile router continues running this intra-domain routing protocol even when it moves away from home and attaches to a visited domain. This is achieved by dynamically modifying the list of the interfaces on which the routing protocol is active. For example, assume a mobile router used interface 'A' when it was connected to its home network and was exchanging routing updates through that interface. When the mobile router moves and attaches to a visited network with the same interface, the routing protocol is turned off for interface 'A'. This is to prevent the mobile router from advertising the routes in its mobile subnet to the visited network.

(6) The mobile router then sets up an encapsulating tunnel to its Home Agent. An encapsulating tunnel is any method, secure or otherwise, that could be used to transmit data between the mobile router and the Home Agent. For example, a packet may be encapsulated in another packet and sent to the home agent. Typically, the tunnel is made secure to provide a secure communication channel. This encapsulating tunnel is then added as a virtual interface to the list of interfaces on which the routing protocol is active. The mobile router then starts sending routing information through this tunnel to the Home Agent. Most IPv6 intra-domain routing protocols assume link-local address to appear as the source address for routing information messages. The encapsulating tunnel takes care of this by encapsulating the routing messages in another IP header. The outer IP header has the source address as the mobile router's current care-of-address and the destination address as the Home Agent's address. When the Home Agent receives the tunneled routing message, it decapsulates it and processes the inner routing message. The inner routing message appears as if the packet was sent from a node on the link.

(7) The mobile router then sends router advertisements to its mobile network, using either a standard Neighbor Discovery protocol or running an

ad-hoc networking protocol, such as AODV (ad hoc on demand distance vector routing protocol), to connect to other mobile hosts

(8) The mobile router makes a rule in its forwarding engine to forward packets between its mobile network and the home network via the bi-directional tunnel established in step 3 (block 430).

Home Agent Changes

FIGURE 5 shows a flowchart illustrating an exemplary method in which a home agent operates. The Home Agent performs the following steps:

(1) The Home Agent adds the bi-directional tunnel set up with the mobile router as one of the interfaces on which the intra-domain routing protocol is active. Then, the Home Agent sends periodic routing updates for the network prefixes that it is able to reach through this tunnel (block 510).

(2) The Home Agent also adds route entries to its routing table for all the prefixes reachable through the mobile router (block 515).

(3) When a packet destined for the mobile router is received by the Home Agent, the binding cache entry for the mobile router is found, and the packet is tunneled to the mobile router (blocks 520 and 525). This is the same as would happen with any other mobile node as defined by Mobile IPv6.

(4) When a packet is received by the home agent that is destined for a node on the mobile network, the home agent finds a route entry for the mobile network where the mobile router is listed as the next hop gateway. The home agent then does another routing lookup for the mobile router and finds the original binding cache entry, causing the packet to be tunneled to the mobile router (blocks 520 and 525). Blocks 520 and 525 may be repeated for each packet the mobile router receives that is destined to the mobile router or a node on the mobile network.

Exemplary Systems

FIGURE 1 shows a block diagram of a mobile router and a mobile node both at home. In the network configuration of FIGURE 1, messages can be routed using normal IPv6 mechanisms. Note that mobile network 105's prefix is aggregated with home network 110's prefix. When mobile router 115 is at home and attached a home link, the packets destined for the mobile network show up on

one mobile router 115's interfaces. Then, mobile router 115 can route the packets to mobile network 105. In this case, mobile router 115 acts as a normal router.

Correspondent node 120 is a node somewhere on the Internet that is trying to send a message. Correspondent node 120 does not need to know anything about mobility of nodes in mobile network 105 to send a message to mobile network 105.

FIGURE 2 shows a block diagram of a mobile node docked in a mobile network. Mobile router 115 is still attached to its home network. A packet from correspondent node 120 to mobile node may be directed in one of two or more paths. If correspondent node 120 does not know anything about the mobility of mobile node 205, correspondent node 120 may send the packet to a home address of mobile node 205. After being transmitted to the home network of mobile node 205, home agent 210 may pick up the packet. After it receives the packet, home agent 210 may perform a lookup on a bindings table 215. In bindings table 215, home agent 210 may find a binding entry that tells home agent 210 a care-of-address for mobile node 205. Home agent 210 may then forward the packet to the care-of-address which causes the packet to be delivered to mobile router 115 and then mobile node 205.

Correspondent node 120 may support binding and be aware of the mobility of mobile node 205. When correspondent node 120 does support binding, correspondent node 120 may send messages directed to mobile node 205's care-of-address.

FIGURE 3 shows a block diagram of a mobile node docked in a mobile network accessed through a mobile router, where the mobile router is attached to a foreign network. Mobile router 115 is attached to visited network 305. Mobile router 115's home network (home network 110) and visited network 305 may be connected through optional inter-operator link 310. Inter-operator link 310 may provide a faster link wherein traffic is not required to go through the Internet when going between routers on home network 110 and visited network 305.

When correspondent node 120 is sending a message to mobile node 205 or any other node on mobile network 105 through mobile router 115, the message will arrive on home network 110. Home agent 315 will see the message and that the message should be forwarded to the mobile network. Home agent 315 will perform a lookup in binding cache 320. When it finds a binding in binding

cache 320, home agent 315 will recognize that home agent 315 should send the message to mobile router 115 at a care-of-address indicated in the binding. Home agent 315 may then send the message through a tunnel through the Internet through visited network router 325 to mobile router 115. In FIGURE 3, mobile router 115 is attached at a care-of-address reachable at visited network 305.

Upon receipt of the packet, mobile router 115 decapsulates the packet and determines that it should route the packet to mobile network 105. Mobile router 115 then sends the message on mobile router 115's other interface to mobile network 105.

When correspondent node 120 is sending a message to mobile node 205 by addressing the message to mobile node 205's home address, the message arrives at home network 125. Home agent 210 sees the message. Home agent 210 performs a lookup in cache bindings 215 and finds that the message should be forwarded to a care-of-address. Home agent 315 may then send the message through a tunnel to the care-of-address. Home agent 315 sees the message and performs a lookup of in cache bindings 320. A binding in cache bindings 320 indicates that the message should be forwarded to mobile network 105. Home agent 315 may then forward the message through a tunnel to mobile router 115. Mobile router 115 may then decapsulate the message and forward the message to mobile network 105.

The various embodiments of the invention may be implemented as a sequence of computer implemented steps or program modules running on a computing system and/or as interconnected machine logic circuits or circuit modules within the computing system. The implementation is a matter of choice dependent on the performance requirements of the computing system implementing the invention. In light of this disclosure, it will be recognized by one skilled in the art that the functions and operation of the various embodiments disclosed may be implemented in software, in firmware, in special purpose digital logic, or any combination thereof without deviating from the spirit or scope of the present invention.

The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.

WHAT IS CLAIMED IS:

1. A method for supporting mobile routers in IPv6, comprising:

obtaining, by a mobile router, a care-of-address associated with an address configuration;

registering, by the mobile router, the care-of-address with a home agent;

establishing, by the mobile router, a bi-directional tunnel between the mobile router and the home agent; and

forwarding configuration information via the bi-directional tunnel employing an address associated with a mobile network.

2. The method of claim 1, further comprising requesting that packets that include an address prefix within a set of prefixes be forwarded to the mobile router.

3. The method of claim 1, wherein the configuration information is static.

4. The method of claim 1, wherein the configuration information is dynamic.

5. The method of claim 1, wherein the configuration information is routing information.

6. The method of claim 1, wherein the mobile router obtains the care-of-address while attaching to a network, the network associated with a network address, the network address including a prefix, and wherein the care-of-address associated with an address configuration is generated by combining the prefix with an identifier that identifies the mobile router.

7. The method of claim 1, wherein the mobile router obtains the care-of-address by at least one of a stateless address autoconfiguration, and a stateful address configuration.

8. The method of claim 1, further comprising encapsulating the configuration information.

9. The method of claim 1, further comprising:

receiving, at the home agent, a packet that includes a home address of the mobile router; and

forwarding the packet via the bi-directional tunnel to the mobile router.

10. The method of claim 9, further comprising employing the home address to retrieve the care-of-address from a table included on the home agent.

11. A method for supporting mobile routers in IPv6, comprising:

updating, by a home agent, a routing table wherein the routing table includes a routing entry associated with a mobile router that is reachable from the home agent;

receiving, by the home agent, a packet;

selecting, by the home agent, a bi-directional tunnel associated with the mobile router;

tunneling, by the home agent, the packet to the mobile router.

12. The method of claim 11, wherein the packet is destined to the mobile router.

13. The method of claim 11, wherein the packet is destined to a node on a mobile network reachable through the mobile router.

14. The method of claim 11, further comprising tunneling, by the mobile router, another packet to the home agent.

15. The method of claim 14, further comprising receiving, by the mobile router, the other packet from a node on a mobile network reachable through the mobile router.

16. The method of claim 11, further comprising:

performing a lookup into a binding cache to obtain a care-of-address associated with the mobile router.

17. A system for supporting mobile routers in IPv6, comprising:

a mobile router;

a home agent; and

a bi-directional tunnel connecting the mobile router to the home agent, wherein the home agent is configured to perform acts, comprising:

receiving a packet that includes a home address of the mobile router, and

forwarding the packet via the bi-directional tunnel to the mobile router, wherein the packet includes an address associated with a mobile network.

18. The system of claim 17, wherein the bi-directional tunnel is configurable.

19. The system of claim 18, wherein the bi-directional tunnel is statically configurable.

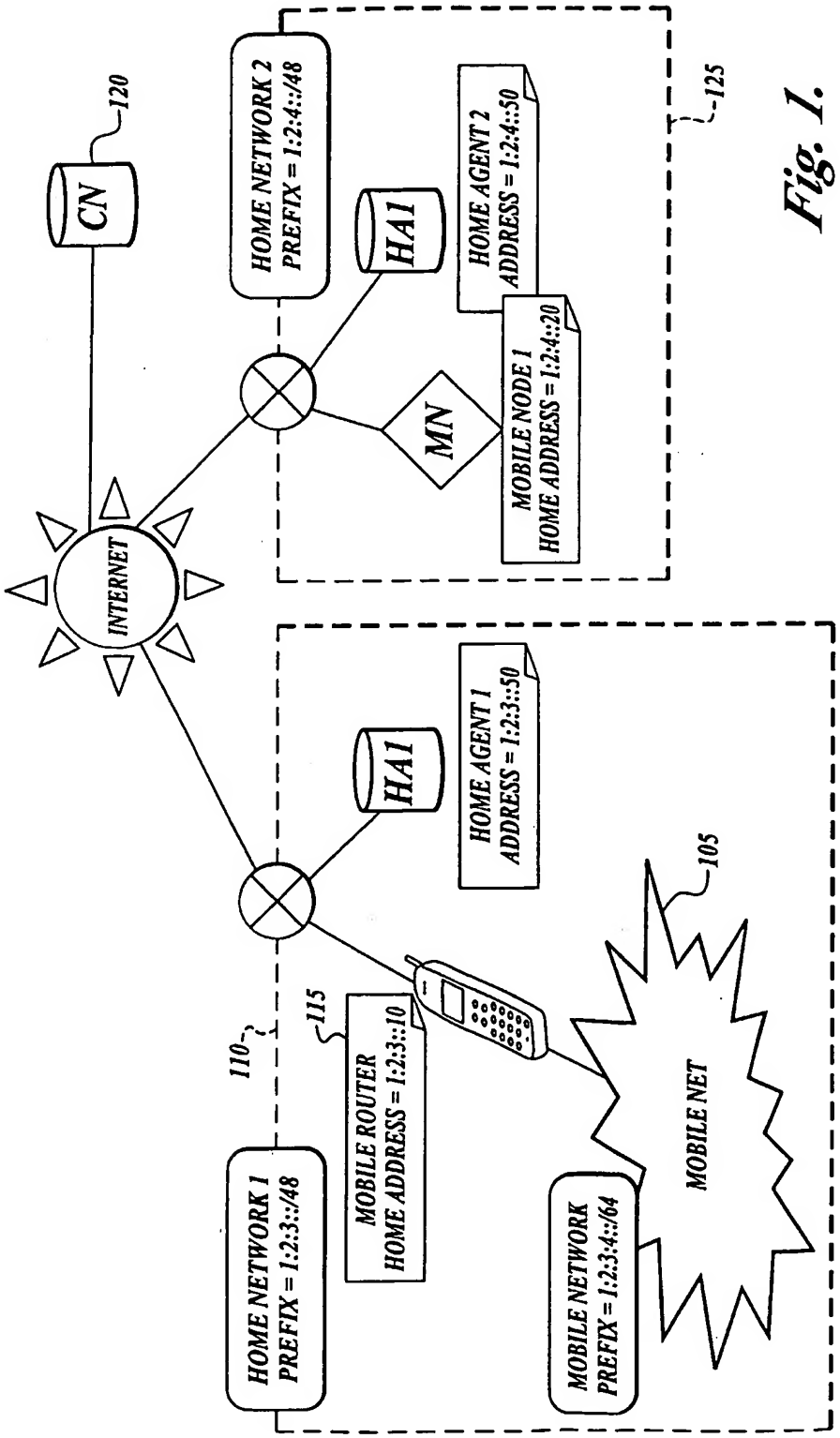
20. The system of claim 18, wherein the bi-directional tunnel is dynamically configurable.

21. A system for supporting mobile routers in IPv6, comprising:

means for forwarding packets to a mobile network;

means for receiving packets at a home network; and

a bi-directional tunnel connecting the means for forwarding packets to the means for receiving packets, wherein a packet that includes a home address of the means for forwarding packets and that is received by the means for receiving packets is forwarded through the bi-directional tunnel to the means for forwarding packets to the mobile network.


CN
120
INTERNET
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HA1
HOME AGENT 2
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MN
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HOME ADDRESS = 1:2:4::20
125
HA1
HOME AGENT 1
ADDRESS = 1:2:3::50
105
110
115
MOBILE ROUTER
HOME ADDRESS = 1:2:3::10
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MOBILE NETWORK
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MOBILE NET

Fig. 1.

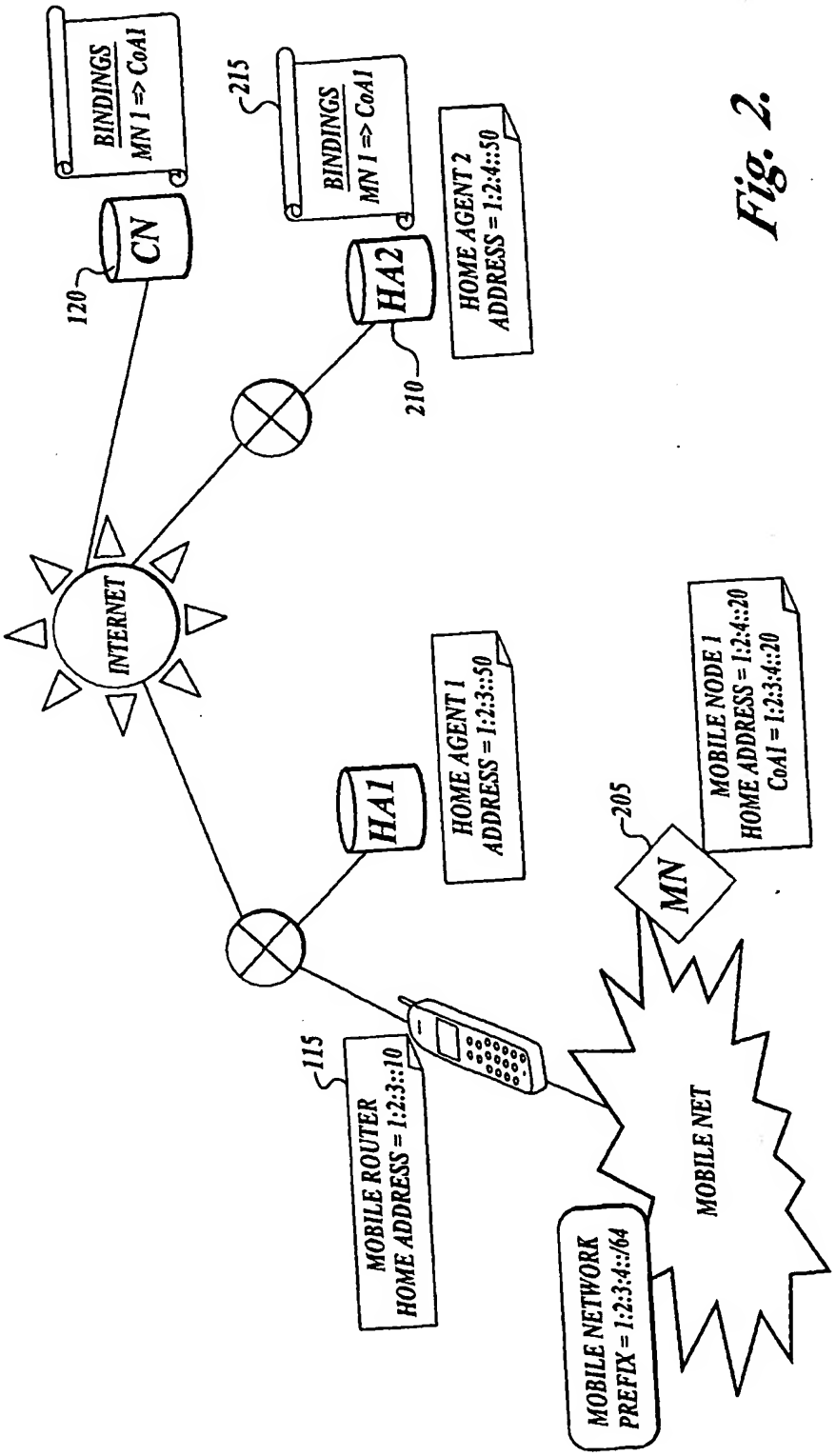
BINDINGS
MN 1 => CoA1
215
BINDINGS
MN 1 => CoA1
CN
120
HA2
210
HOME AGENT 2
ADDRESS = 1:2:4::50
INTERNET
HA1
HOME AGENT 1
ADDRESS = 1:2:3::50
MOBILE NODE 1
HOME ADDRESS = 1:2:4::20
CoA1 = 1:2:3:4::20
205
MN
115
MOBILE ROUTER
HOME ADDRESS = 1:2:3::10
MOBILE NET
MOBILE NETWORK
PREFIX = 1:2:3:4::/64

Fig. 2.

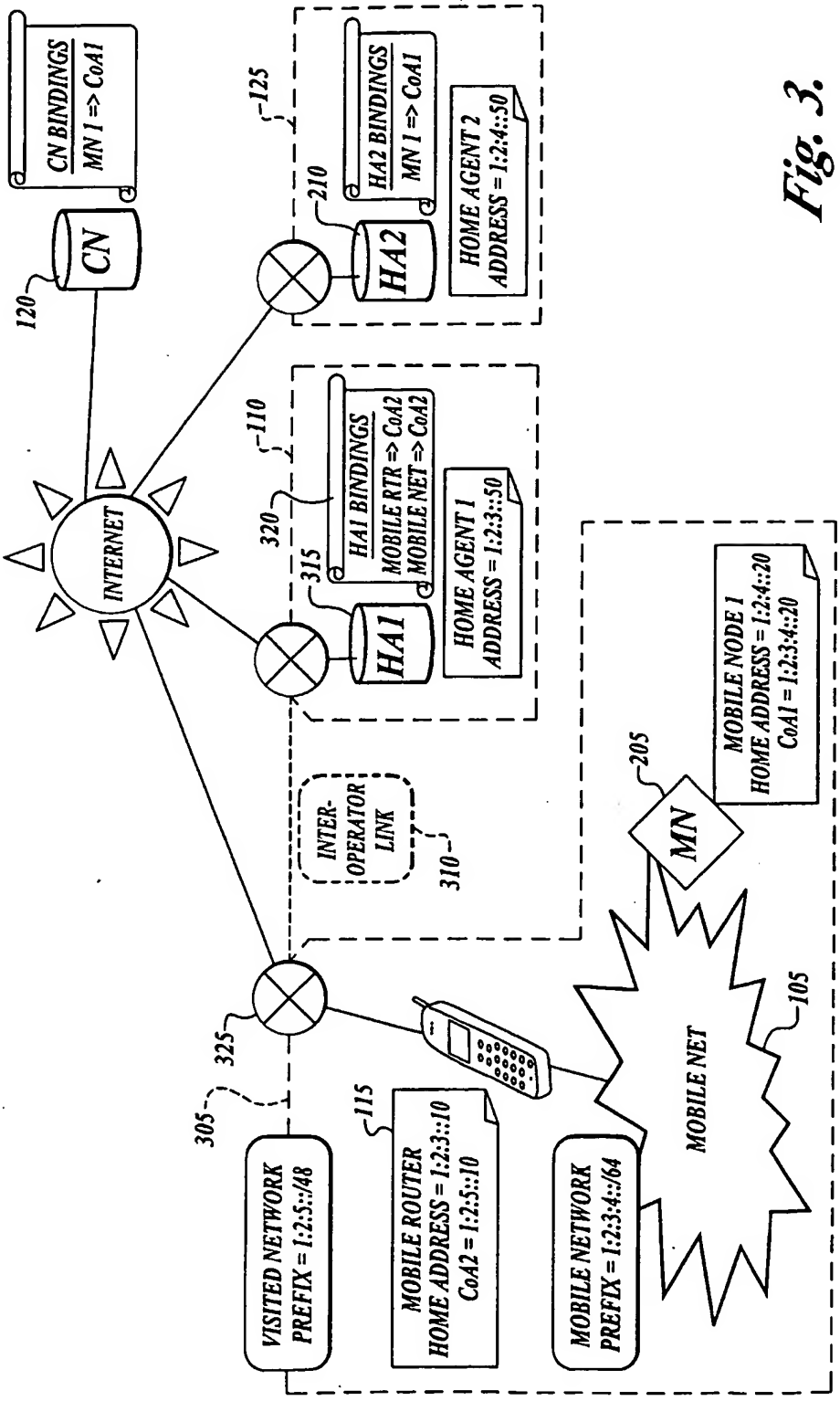
CN BINDINGS
MN 1 => CoA1
CN
120
INTERNET
125
210
HA2 BINDINGS
MN 1 => CoA1
HA2
HOME AGENT 2
ADDRESS = 1:2:4::50
110
320
315
HA1 BINDINGS
MOBILE RTR => CoA2
MOBILE NET => CoA2
HA1
HOME AGENT 1
ADDRESS = 1:2:3::50
INTER-OPERATOR LINK
310
205
MN
MOBILE NODE 1
HOME ADDRESS = 1:2:4::20
CoA1 = 1:2:3:4::20
325
305
115
105
VISITED NETWORK
PREFIX = 1:2:5::/48
MOBILE ROUTER
HOME ADDRESS = 1:2:3::10
CoA2 = 1:2:5::10
MOBILE NETWORK
PREFIX = 1:2:3:4::/64
MOBILE NET

Fig. 3.

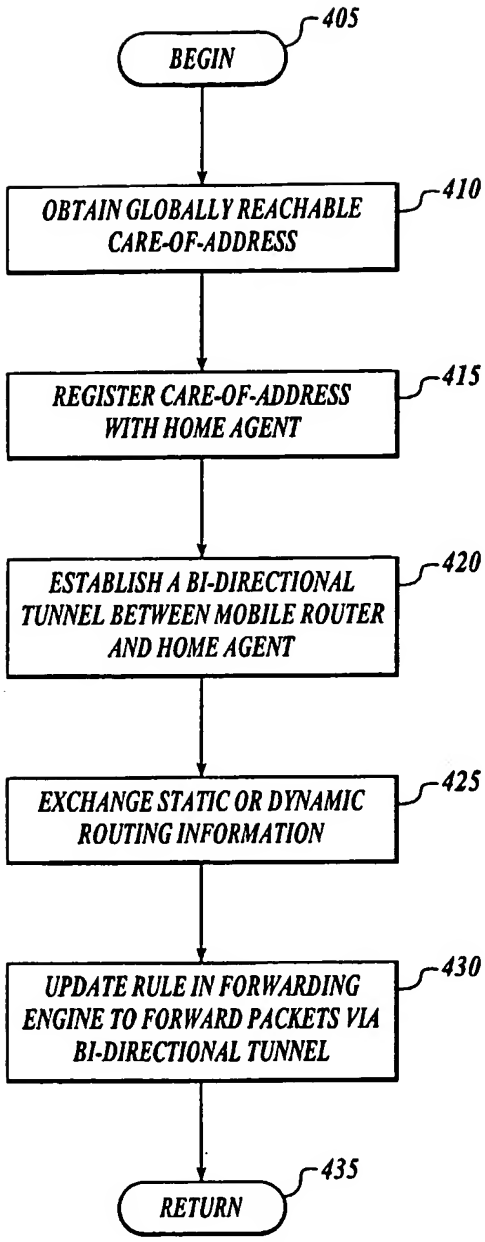
405
BEGIN
410
OBTAIN GLOBALLY REACHABLE CARE-OF-ADDRESS
415
REGISTER CARE-OF-ADDRESS WITH HOME AGENT
420
ESTABLISH A BI-DIRECTIONAL TUNNEL BETWEEN MOBILE ROUTER AND HOME AGENT
425
EXCHANGE STATIC OR DYNAMIC ROUTING INFORMATION
430
UPDATE RULE IN FORWARDING ENGINE TO FORWARD PACKETS VIA BI-DIRECTIONAL TUNNEL
435
RETURN

Fig. 4.

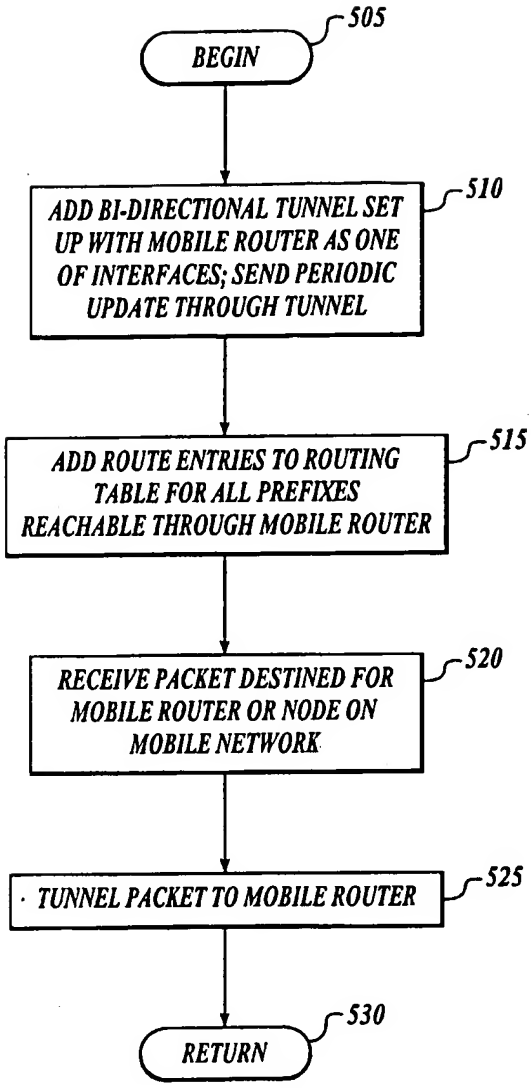
505
BEGIN
510
ADD BI-DIRECTIONAL TUNNEL SET UP WITH MOBILE ROUTER AS ONE OF INTERFACES; SEND PERIODIC UPDATE THROUGH TUNNEL
515
ADD ROUTE ENTRIES TO ROUTING TABLE FOR ALL PREFIXES REACHABLE THROUGH MOBILE ROUTER
520
RECEIVE PACKET DESTINED FOR MOBILE ROUTER OR NODE ON MOBILE NETWORK
525
TUNNEL PACKET TO MOBILE ROUTER
530
RETURN

Fig. 5.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/36607

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H04B 7/24, 7/26

US CL : 370/328,338

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 370/310,315,328,338

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

IEEE Xplore

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST

search terms: mobile IP, tunnel, mobile router,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,061,650 A (MALKIN et al) 09 May 2000, col. 2, lines 58-65; col. 5, lines 53-64; and col. 6, lines 25-45.	1-21
Y	US 6,240,089 B1 (OKANOUE et al) 29 May 2001, col. 5, line 57-col. 6, line 9.	1-21
Y	US 6,285,680 B1 (STEINKA et al) 04 September 2001, col. 4, lines 55-67.	1-21
Y	US 6,195,705 B1 (LEUNG) 27 February 2001, col. 23, lines 19-39.	1-21
Y	US 5,781,772 A (WILKINSON, III et al) 14 July 1998, col. 1, line 63-col. 2, line 9.	2,6
Y	US 6,061,712 A (TZENG) 09 May 2000, col. 1, lines 13-54.	2,6

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
30 JANUARY 2003	07 MAR 2003
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer DANIEL RYMAN Telephone No. (703) 305-6970

Form PCT/ISA/210 (second sheet) (July 1998)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/56607

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,223,172 B1 (HUNTER et al) 24 April 2001, col. 1, lines 40-49.	2,6
Y	US 6,269,099 B1 (BORELLA et al) 31 July 2001, col. 1, line 11-col. 2, line 6.	3,4
Y	US 5,796,740 A (PERLMAN et al) 18 August 1998, col. 7, lines 38-58.	5,6,11-16
Y	US 6,256,300 B1 (AHMED et al) 03 July 2001, col. 4, lines 5-15.	6
Y	PERKINS, C.E.; BOUND, J. Computers and Communications, 1998 ISCC '98 Proceedings. Third IEEE Symposium on, 30 June-2 July 1998. pages 493-497, especially 493, column 1.	7
Y	US 6,101,543 A (ALDEN et al) 08 August 2000, col. 2, lines 25-39 and col. 6, lines 30-45.	18-20